Research Article

Nesting Behavior of Kalimantan Orangutan *Pongo pygmaeus* as a Release Subject at Forest School Sekolah Hutan Tembak Lestari, Sintang, West Kalimantan, Indonesia

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Abstract | This research investigated nesting behavior in Bornean orangutans (*Pongo pygmaeus*) as a suitable release subject at the Sekolah Hutan Tembak Lestari forest school, Sintang, West Kalimantan, Indonesia. This study aims to evaluate two orangutan release candidates through nest-building skills. These two orangutans were observed daily between 04:30 and 06:30 pm from September to November 2019 using continuous focal animal and all-occurrence sampling methods. Nest-building skills were assessed using the Likert scale. Moni (male orangutan) was always observed to nest using used nests. Meanwhile, Terra (female orangutan) was frequently observed building new nests, although she was caught sleeping on the forest floor several times. During observations, it was found that they prefer nest trees with a circumference of more than 1 m with a reasonably dense canopy refers preferred trees that serve as nesting sites, those are bambang tree (*Lithocarpus* sp.) with a tree circumference of 3 m and kempilik tree (*Quercus* sp.) 2.46 m and often reuse or rebuild old nests. Our results showed that both orangutans had moderate predicate nest-building skills, with a percentage of 68.06% for Moni and 63.89% for Terra. Nonparametric Mann-Whitney U statistical tests, ($\alpha = 0.05$; $p = 0.415$) showed that the nest-building ability between the two individuals is not significantly different. With nest-building ability not significantly different between the two orangutans with a moderate predicate, the two orangutans can be released together.

Keywords | Forest school, Nest building, *Pongo pygmaeus*, Rehabilitant orangutan, Release criteria

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INTRODUCTION

The Kalimantan orangutan (*Pongo pygmaeus*) is one of the Asian great apes whose distribution is limited to Kalimantan and some parts of Malaysia (Sunderland-Groves et al., 2021; Rocque et al., 2022). The International Union for Conservation of Nature (IUCN) classified it as Critically Endangered. Simultaneously, it is listed as Appendix I (trade prohibited) in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (Ancrenaz et al., 2018).

The conservation status was given to *P. pygmaeus* based on habitat loss and population decline due to land conversion and conflict with humans (Yuliani et al., 2023). The cause of the conflict is often due to orangutans trespassing into community gardens and eating the produce. Nursing orangutans are shot and often killed, and babies are sold on the black market for pets (Davis et al., 2013; Gnuse, 2022; Sherman et al., 2020).

The rise of the orangutan trade, conservation status, and conflict have prompted many Non-Governmental Organizations (NGOs) working in orangutan protection to participate in rehabilitating those that humans previously kept. An example is the forest school Sekolah Hutan Tembak Lestari, a program to prepare orangutans for release, owned by Sintang Orangutan Center (SOC) (Rifanjani and Siahaan, 2017). They focus on rescuing, rehabilitating, and releasing orangutans (Sumaya, 2021).

The rehabilitation program trains orangutans to survive when released into their natural habitat. Furthermore, those considered capable of surviving in the wild are released to a different location from the previously released orangutan group. The purpose of release programs is to establish a new population in an area and increase the effectiveness of the conservation of the forest area where they are released (Santosa and Rahman, 2012; Sherman et al., 2020).

Nesting ability is one of the fundamental skills of great apes in surviving in the wild (Casteren et al., 2012). Nesting ability is one of the top priorities in releasing orangutans back into the wild (Rosen and Buyers, 2002). Rehabilitated orangutans should be able to build and use nests during the school observation period. In the wild, orangutan nesting helps open up the dense canopy of the forest, allowing sunlight to freely penetrate the forest floor (Santosa and Rahman, 2012).

Orangutans build new nests every night for rest, and they rarely reuse old nests or reused nest (Rayadin and Saitoh, 2009; Prasetyo et al., 2009). According to Niningsih et al. (2021) reused nest, the orangutan reused the old nets either by repairing or without any reparation. Orangutans usually repair the old nest by adding fresh leaves or limbs. The nest can belong to both the same individual and other individuals. Orangutans are highly selective when choosing nest trees due to preferences for leaves, branches, and twigs used for foundation and nodes (Nayasilana et al., 2020). According to Fiore and Suarez (2007), intersections or "nodes" may be sites where animals can jump from one route to the next. Orangutans also like to nest in a position not far from the canopy, and they prefer closed canopies to avoid attacks by night predators (Ancrenaz et al., 2004).

In forest school Sekolah Hutan, orangutans to be released are taught how to build nests. Evaluation of orangutan nests is one of the parameters of readiness for release. Until the time of the research, there was no data on the evaluation of orangutan nesting skills after forest school as a parameter for preparation for release. This research aims to assess the nesting behavior of two orangutan release candidates at forest school Sekolah Hutan Tembak Lestari based on the ability to build a nest, the characteristics of the selected nest trees, and the position of the most frequently used nests.

MATERIALS AND METHODS

Description of the Research Location

This research was conducted over two months, from September to November 2019, in the inner enclosure of forest school Sekolah Hutan Tembak Lestari, Gurung Malih Village, Sintang District, West Kalimantan Province, Indonesia (Figure 1). The condition enclosure inside the forest school is part of the Ribang Ayau customary forest, which the SOC uses as a rehabilitation center and educational area for orangutans in the wild forests.

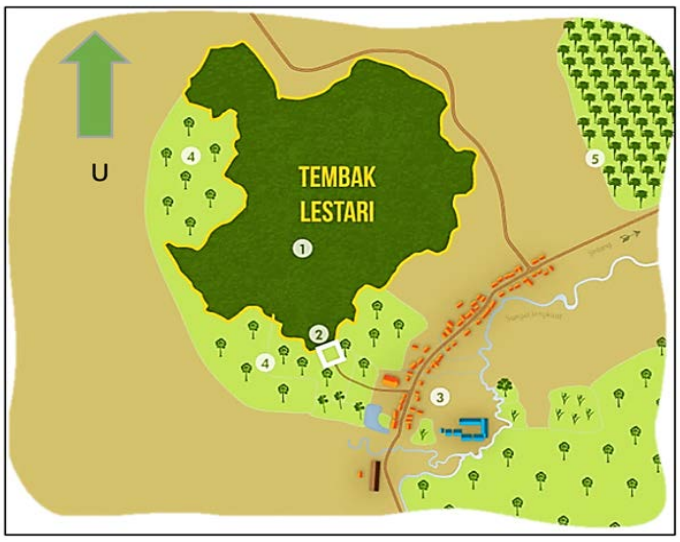

Figure 1: Location of Sekolah Hutan Tembak Lestari (1), Clinic (2), Settlements/ Settlements of Residents (3), Customary Forest (4), Palm Forest (5) (Source: official website of SOC).

Study Subjects

The research subjects were 2 Bornean orangutan adolescents, known as Moni (male) and Terra (female) (Figure 2), both six years old and release candidates. Observation of the subject orangutans in their cages started at 16:30 to 18:30 for six days. They were observed alternately weekly, and data was collected using focal animal all-occurrence sampling (Altmann, 1974; Samson et al., 2015). The data recording started when the subject entered the forest school area to either start building or renovating a nest. Focals were observed at a distance of approximately 20 meters. Therefore, they were not affected by the presence of the observer. The criteria observed included the species of leaves and trees used for nesting, the position of the nest to be built, and nesting activities such as renovating and building new nests.

Nest tree selection is essential for orangutans because arboreal nests require a sturdy tree trunk, a good tree canopy

to cover the tree, and a tree circumference of more than 1 meter. The preference for trees used for nesting is similar to the research conducted by Prasetyo et al. (2009) on wild orangutans. There are five commonly used orangutan nest positions (Figure 4). Position 1 nests are built between the main branch and trunk by rotating the branches horizontally to form nest pods. Nest pods or baskets are for captive orangutans or apes (Anderson et al., 2019). Position 2 nests use horizontal side branches to build a nest foundation (Prasetyo, 2006; Prasetyo et al., 2009). The position 3 nest is at the apex of the main trunk and is formed by bending the branch at the top of the tree as the nest foundation. Nest position 4 has a nest foundation formed from several tree branches. Position 0 is on the forest floor for building a nest (Prasetyo et al., 2009; Prasetyo et al., 2012).

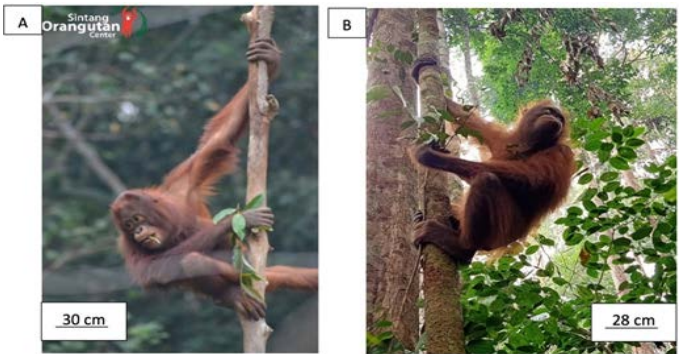

Figure 2: Candidate orangutans, Moni (A) and Terra (B) (Source: Personal Communication).

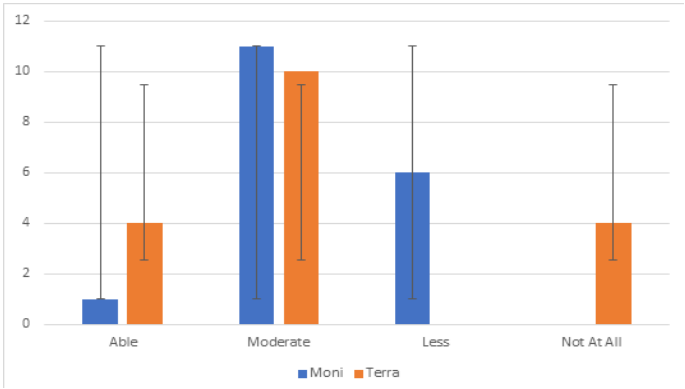

Figure 3: Graph of daily observation of nesting ability of Moni dan Terra

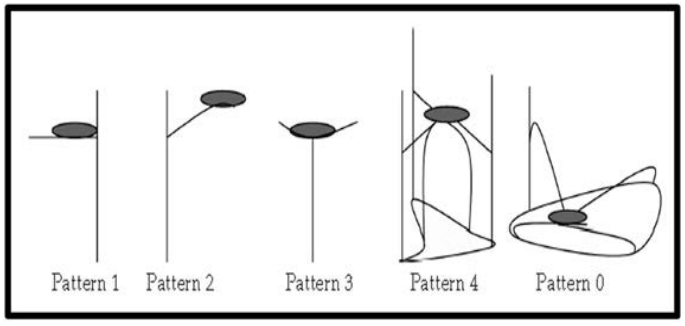

Figure 4: Five nest positions are usually used by orangutans (Prasetyo et al., 2009).

Data Analysis

Martinez (2016) evaluated nesting ability using the Likert scale, which can be divided into four (four) predicates: Able, Moderate, Less, and Not At All (Table 1). The assessment on the observation sheet was divided based on the ability to build a nest with different percentage values for each predicate. The 'Able' predicate is given to orangutans which can build new nests or renovate the old ones within a few minutes or more (MacKinnon, 1971; Rifai et al., 2013). The predicate 'Moderate' is given when orangutans only renovate two or more components of the old nest in less than 5 minutes. While the predicate 'Less' is given when they only change the leaves of the old nest floor or sleep in it without any renovation. Orangutans are given the predicate 'Not At All' when they rarely use nests or do not nest at all.

Observations on the ability to build a nest were converted into percentages and presented in graphical form. The percentage yield refers to the predicate on the ability to build a nest listed in Table 1 and is one of the assessment criteria in determining the subject's release. Data were tested using the U Mann-Whitney nonparametric test to determine whether there were any differences in the ability to build a nest between the two orangutans.

Table 1: Average nesting ability (Moni and Terra) and likert scale for nesting ability predicate of orangutan

Orangutan	Average (%)	Predicate	Sig. (2 tailed)/ P-Value	Percentage (%), Predicate (Martinez, 2016).
Moni (male)	68.06	Moderate	0.415	0 - 25, Not at all
				26 - 50, Less
Tera (female)	63.89	Moderate		51 - 75, Moderate
				76 - 100, Able

RESULTS

Nest Building Ability

The results on the nesting behavior of male (Moni) and female (Terra) orangutans are described in Figure 3. The highest achievement in the nesting ability of the two release candidate orangutans was in the 'Moderate' predicate with a percentage value of 68.06% for Moni (male) and 63.89% for Terra (Female). It was observed that Moni could only build a new nest once in 5 minutes or more, while Terra was more frequent, namely 4 (four) times.

Furthermore, when renovating two or more parts of an old nest in less than 5 minutes, Moni did it 11 times and Ter

Table 2: Tree and nest condition in Tembak Lestari forest school

No	The local name of the tree (scientific name)	Estimated tree height (m)	Estimated nest height (m)	Tree circumference (m)	New/old nest	Position of nest	User
1	Bambang (*Lithocarpus* sp.)	30	25	3	Old	2	Moni
2	Kempilik (*Quercus* sp.)	20	13	2.46	Old	2	Moni; Terra
3	Rengas (*Gluta* sp.)	15	10	0.92	New	2	Terra
4	Ubah (*Syzygium* sp.)	20	15	1.76	New	3	Terra
5	Bubuk	20	15	0.82	New	2	Terra

ra 10 times. Moni was observed six times changing the leaves of the old nest floor or sleeping on it without any renovation, something Terra never did. During the observation period, it was found that Moni always slept in the nest. However, Terra was observed not sleeping in the nest about four times. The ability to build nests between Moni and Terra showed no significant difference (Mann-Whitney U, p = 0.415).

Nest Tree Characteristics and Nest Position

During the research period, the two orangutan release candidates could use trees in the forest area to build new nests and nest positions often found in position' pattern 2' (Table 2).

DISCUSSION

Nest building ability

The graph in Figure 3 shows that Moni's ability to build nests was more consistent than Terra, even though they both had the same predicate. Moni is therefore considered a more capable nest builder because he always uses nests, even though he often reuses or rebuilds old nests. Meanwhile, Terra was considered less competent because she was observed several times displaying no nesting behavior. Terra did not sleep in a nest four times during the observation period, instead choosing to sleep on the forest floor, following other male orangutans (not a release candidate). Terra's behavior was caused by Terra's interest in other male orangutans. We believe the absence of consistent nesting behavior reduces Terra's ability to survive in the wild.

During the observation period, Moni demonstrated appropriate behavior with wild male orangutans, such as nesting in trees that had been occupied and close to previously constructed nests. Moni also reused old nests overnight, as seen in other populations (Ancrenaz et al., 2004; Russon et al., 2007; Basalamah et al., 2018; Nayasilana et al., 2020). The tendency of male orangutans to utilize old nests depends on their availability and whether they remain suitable for use (Ancrenaz et al., 2004; Russon et al., 2007; Bani et al., 2018). Furthermore, the forest school area provides the opportunity to use old nests or solo nest practices. During this stage, they may be able to judge whether a nest should be used as a place for sleeping at night or not.

We observed that the nesting preferences of the two orangutans differed. Moni always sought old nests that fit his relatively large body size, close to feeding trees. His tendency to be close to a food source indicates that Moni's nesting behavior is under the findings of Fauzi et al. (2020). Moni could be interested in not feeling the impact while nesting near a food source tree. Terra was observed to build new nests frequently and only occasionally reuse existing ones.

Nest tree characteristics and nest position

It is shown in Table 2 that there were abandoned nests in the bambang (*Lithocarpus* sp.) and kempilik (*Quercus* sp., F. Fagaceae) tree species which were made using leaves from the tree where the orangutan nested. The nests were made by orangutan individuals previously educated in the forest school. Although nest locations were not chosen randomly, and there were preferences for trees (Prasetyo et al., 2009, Ancrenaz et al., 2004), old nests could directly affect the two orangutans' release candidates. Furthermore, they could be used to evaluate nesting behavior because they respond differently to orangutans. The male orangutans renovate their nests whenever they feel it is still good enough to be occupied. While female orangutans rarely renovate their nests and always tend to build new ones. This nesting behavior follows the opinion of Prasetyo et al. (2012).

Based on the trees used by the two orangutans, the nests were observed in each tree, and their preferences are shown in Table 2. Moni preferred trees with a circumference of more than 2 meters. Terra did not prefer any particular tree circumference due to her relatively smaller size than Moni (Moni 55 kg and Terra 35 kg), meaning a wider variety of trees may be suitable for her nests. There were two old nests used by Moni where he was observed selecting new leaves, cleaning old leaves and repairing some of the branches that were part of the nests. Furthermore, the reuse of old nests was highest in bambang and kempilik trees. The average circumference of a bambang tree is 3 meters and 2.5 meters for kempilik. The possibility of choosing a tree species is based on its sturdy trunk with a relatively large circum-

ference (± 3 meters) and a dense canopy. The most common position of nests in bambang, kempilik, rengas, and bubuk trees was position 2 (Figure 4), while in trees that change, the position of the nest was depicted as position 3. Apical position nests and those far from the mainstem on horizontal branches (position 2) are often used by orangutans during observations in forest schools (Table 3) because both positions have a larger area for orangutans to build nests, according to Prasetyo et al. (2009).

Table 3: Percentage of use nest position on trees in forest school

No	Position of nest	Frequency of usage		Percentage of usage (%)	
		Moni	Terra	Moni	Terra
1	0	0	0	0	0
2	1	0	0	0	0
3	2	18	14	100	77.77
4	3	0	1	0	5.55
5	4	0	0	0	0

CONCLUSION AND RECOMMENDATIONS

In conclusion, our assessment of nest-building skills of two release candidate orangutans gives both orangutans had moderate predicate nest-building skills, with a percentage of 68.06% for Moni and 63.89% for Terra. Non-parametric Mann-Whitney U statistical tests, ($\alpha = 0.05$; $p = 0.415$) showed that the nest-building ability between the two individuals is not significantly different. They prefer nest trees with a circumference of more than 1 m with a reasonably dense canopy refers preferred trees that serve as nesting sites, those are bambang tree (*Lithocarpus* sp.) with a tree circumference of 3 m and kempilik tree (*Quercus* sp.) 2.46 m and often reuse or rebuild old nests. With nest-building ability not significantly different between the two orangutans with a moderate predicate, the two orangutans can be released together.

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CONFLICT OF INTEREST

The authors have declared no conflict of interest.

NOVELTY STATEMENT

There is no data on evaluating orangutan nesting skills after the forest school program at Sekolah Hutan Tembak Lestari, Sintang, West Kalimantan, Indonesia, as a parameter for preparation for release.

AUTHORS' CONTRIBUTIONS

LS, ZAS, and TMS contributed equally to field observations, and analyzed, wrote and edited the article. All authors read and approved the final manuscript.

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